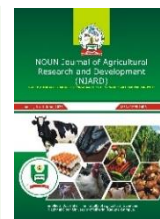




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**Original Article**

**Influence of arbuscular mycorrhizal fungi (*Glomus intraradices*) and compost fertilizer on selected soil properties, growth and yield of okra (*Abelmoschus esculentus* L (MOENCH)) in Niger State.**



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**Abstract**

This experiment evaluated the potentials of Arbuscular Mycorrhizal Fungi ((AMF) *Glomus intraradices*) and compost fertilizer (CF) on okra performance and selected soil properties. Four treatments consisting of sole AMF (10 g plot<sup>-1</sup>), CF (500 g plot<sup>-1</sup>), their combination (AMF+CF; 5 g+250 g plot<sup>-1</sup>) and an absolute control was laid in a Randomized Completely Block Design (RCBD) replicated three times at the Horticulture and Landscape Teaching and Research farm, Federal University of Technology, Minna, Niger State. Okra (Clemson spineless) was grown till maturity; growth and yield parameters were taken, selected soil physical and chemical properties were carried out in Soil Science and Land Management, laboratory, F.U.T. Minna. Significant treatment means were separated using Least Significant Difference ( $p < 0.05$ ). The results shows that for most okra growth parameters taken (Plant height, stem girth, number of leaves, fruit number and fruit weight), significant ( $P < 0.05$ ) increase with the application of AMF, AMF+CF compared to the sole use of CF and control were observed. Likewise, the use of AMF, AMF+CF and CF, increased Total Nitrogen, Available phosphorus and Organic carbon in soil as compared to the control plot after harvest. This implies that the use of AMF, AMF+CF and CF are beneficial to the enhancement of okra growth and yield and could serve as a promising soil fertility amendment if well managed.

**Keywords:** *Glomus Intraradices*, Soil amendment, Compost, Organic carbon, Sustainable Agriculture.

**INTRODUCTION**

Continuous decline in soil fertility affecting okra yield despite its nutritional and economical benefit, has been reported severally (Babatola, 2006, Wahyuni *et al.*, 2014, Odedokun *et al.*,

2023). This was substantiated by Anyaegbu *et al.* (2013) who reported that the growth and yield of okra crops in Nigeria are limited due to low fertility nature of most soils in many parts of the country due to continuous cropping, removal of crop residues, unsustainable farming practices and



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short fallows leading to soil degradation and reduced agricultural productivity, hence negatively affecting the economic landscape of farmers. Positive response of okra to the use of mineral fertilizer has been well reported (Khetran *et al.*, 2017), however this fertilizer is often scarce, expensive and not environmentally friendly. Alternatively, the use of compost fertilizer supply nutrients to the soil and their effects last longer than mineral fertilizers because they are slow releasers (Kayode *et al.*, 2018), it also improves soil physical properties such as soil bulk density, water retention capacity, infiltration and aeration. Utilizing organic fertilizer such as compost has been shown to improve soil health by enhancing nutrient availability and promoting beneficial microbial activity (Agbede, 2010).

The use of bio-fertilizer such as Arbuscular Mycorrhizal Fungi (AMF) is another neglected promising soil amendment strategy. AMF colonize the roots of many agriculturally important food and bio-energy crops and could serve as bio-fertilizers and bio-protectors in environmentally sustainable agriculture (Buckling *et al.*, 2012). AMF are the most common form of mycorrhizal interactions, formed by a wide variety of host plants (approximately 65 % of all known land plant species) including many agricultural important crop species, such as soybean, corn, rice and wheat. AMF according to Hirji, (2016) may boost agricultural productivity and quality. The need to argument soil fertility status is daily becoming necessary due to the non sustainable farm practices peasant farmers are adopting lately due to increase in population leading to tense demand for land use. It is therefore imperative to evaluate the effect of compost and AMF (*Glomus intraradices*) as sole and combine fertilizer on okra cultivation and on soil health.

## MATERIALS AND METHODS

The field experiment was conducted during the 2023 raining season at the experimental farm of the Department of Horticulture and Landscape, Federal University of Technology, Minna, Niger State Nigeria. The farm is situated at Longitude 9° 31' 50.28"E and Latitude 6° 27' 00.37"N at an elevation of 240 meters above sea level. Top soil samples (0-15 cm) were taken randomly for

selected physical and chemical properties using auger from the experimental field, air-dried, sieved appropriately and analyzed. The soil particle size, pH (H<sub>2</sub>O), organic carbon, total N (TN), available phosphorus (AP), potassium (K), calcium (Ca), magnesium (Mg) and sodium (Na) were determined Table 1.

Particle size analysis was determined using the Bouyoucos hydrometer method described by (Sheldrick and Hand Wang 1993). pH was determined in water 1:2 soil:water ratio using electrometric method (IITA, 1982). Total N was determined using the micro kjeldhal procedure as described by (Bermner, 1996). Organic carbon was determined by walkley black method, Available P was determined using Bray P1 method (IITA, 1982). Exchangeable Ca, Mg, K and Na were determined by extraction with 1N ammonium acetate and the amount of Ca and Mg were determined using Atomic Absorption Spectrophotometer (AAS). K and Na in the filtrate was determined using flame photometer. Manual land clearing was carried out using hoes, cutlass and rake. The plots were partitioned into unit plots of 3 m × 1.5 m and ridges made with 1 m margin in-between each plot. Two weeks before planting Treatment 1: AMF *Glomus intraradices* (10 g), treatment 2: Compost made from plant residue (500 g (5 t ha<sup>-1</sup>)), treatment 3: the combination of half the rate of each (AMF+CF) were incorporated into the soil and treatment 4 was the control, all replicated thrice. The experiment was laid in Randomized Complete Bock Design (RCBD). Okra seeds were sowed at the rate of three per hole at inter and intra row spacing of 80 cm × 50 cm, thinned to one per hill two weeks after germination, other necessary agronomic practices were done as at when required. Collected data were subjected to analysis of variance (ANOVA), using GenSTAT (11<sup>th</sup> Edition). Significant treatment means were separated using Least Significant Difference (LSD) at 5 % level of probability.

## RESULTS AND DISCUSSION

The initial analysis shows that (Table 1) the study area soil is slightly acidic (6.75) and sandy loam in texture. The total N (TN), organic carbon (OC) were low 0.28 and 1.69 g kg<sup>-1</sup> respectively, exchangeable bases (Ca, Mg, K and Na) were all



low affirming the need for soil fertility argumentation according to Chude *et al.* (2011) nutrient rating of soil fertility classes in Nigeria. However, available P and exchangeable acidity were moderate. The consistent increase in TN, AP and OC after okra harvest with regards to the application of AMF+CF compared to control, though: low for TN, OC and medium for AP according to Chude *et al.* (2011), reveals that the various soil amendments investigated have the tendency to sustain the fertility status of the soil compare to the tested soil initial status, these can be attributed to the synergy that must have resulted between the AMF and CF Table 2. High content of AP were observed in all the AMF treated soils relative to CF treatments and more than the value in control soil (Table 2) similar to the findings by Adewole and Ilesanmi, (2011). This proved the ability of AMF to release and encourage absorption/uptake of P in the soil as earlier reported by Smith and Read (1997) which stated that AM are very effective in helping the plants to absorb P from the soil and invariably prevents P runoff that leads to eutrophication (undesired biological growth and productivity). Increased phosphorous availability and uptake by mycorrhizal plants can reduce P requirement in the soil and decrease the accumulated phosphorous in soil and water.

**Table 1: Initial physico-chemical properties of the experimental soil**

Soil Properties	Values
<b>Particle size distribution (g kg<sup>-1</sup>)</b>	
Sand	782.4
Silt	122.8
Clay	94.8
Textural Class	Loamy
pH (1:2.5)	6.75
Available Phosphorus (mg kg <sup>-1</sup> )	10.88
Total Nitrogen (g kg <sup>-1</sup> )	0.28
Organic Carbon (g kg <sup>-1</sup> )	1.69
<b>Exchangeable Bases (cmol kg<sup>-1</sup>)</b>	
Ca <sup>2+</sup>	3.36
Mg <sup>2+</sup>	0.88
K <sup>+</sup>	0.08
Na <sup>2+</sup>	0.16
Exchangeable Acidity (cmol kg <sup>-1</sup> )	1.18

**Table 2: The effect of AMF and compost on selected soil properties after harvest**

Treatments	N	AP	OC
AMF	0.25	12.62	0.24
AMF+CF	0.34	14.45	3.24
CF	0.15	10.46	2.16
Control	0.13	5.97	2.76

Okra plant height significantly respond to the application of AMF and its combination with compost fertilizer (AMF+CF) at various growth stages. AMF recorded 33, 52, 34 and 19 % increase in plant height at 3, 6, 9 and 12 WAP over control respectively. When it was combined with compost it also recorded 26, 31, 56 and 42 % increase in plant height at 3, 6, 9, and 12 WAP respectively compared to control. Likewise, substantial significant level of increase was observed with the use of AMF+CF as compared to CF only resulting in 17, 38, 40 and 24 % increase in plant height at 3, 6, 9 and 12 WAP respectively. This is in line with Ogbodu, (2015) findings. The stem girth also significantly responded to AMF only and AMF+CF over the control all through the period of observation even at the 12<sup>th</sup> week it had 31 and 39 % increase in stem girth for AMF and AMF+CF as compared to control respectively, furthermore the combination of AMF+CF had more than 100 % significant increase in stem girth as compared to the use of CF only Table 3. The significant similar response of okra plant growth parameters observed are strong indications that the amendment of soil with AMF and AMF+CF are necessary for okra improvement which will eventually increase the sink. Similar to Carrillo *et al.*, (2017) who affirmed increase in plant height, chlorophyll content and fruit commercial yield of clemson spineless as a result of AMF application. Likewise, Ziane *et al.*, (2017) reported that the overall height and biomass of tomato inoculated with the commercial AMF inoculum were significantly increased.

**Table 3: Effect of AMF and compost on okra growth (WAP)**

Treatment	Plant Height (CM)				Stem Girth (MM)			
	3	6	9	12	3	6	9	12
AMF	36	91	163	228	0.47	1.4	1.87	1.87
AMF+CF	34	87	189	272	0.48	1.2	1.88	1.99
COMPOST	29	66	135	219	0.42	0.9	1.47	0.93
CONTROL	27	60	121	191	0.39	0.73	1.04	1.43
LSD	4	26	57	70	0.06	0.35	0.69	0.7

There were no significant differences observed with respect to number of branches at the 3<sup>rd</sup> and 9<sup>th</sup> WAP, however the use of AMF and AMF+CF resulted in significant number of branches at 6<sup>th</sup> and 12<sup>th</sup> weeks more control Table 4. The number of leaves of okra resulted in significant increase of 40, 65, 41 and 118 % when AMF was used at 3, 6, 9 and 12 WAS over the control respectively, this definitely will enhance the source by giving room for effective photosynthesis. Likewise AMF+CF also led to 27, 50, 48 and more than 100 %

additional number of leaves over the control at the various weeks respectively. The use of AMF+CF also recorded 19, 36, 54 and 40 % increase in number of leaves as compared to the application of CF only. Mutumba *et al.*, (2018) documented the effect of mycorrhizal fungi on improving plant growth parameters and chlorophyll index of the host plant, an attribute which is aggravated with the combination of compost as a result of the presence of organic matter, therefore the more the leave formed the more the chlorophyll formation.

**Table 4: Effect of AMF and compost on okra growth (WAP)**

Treatments	Number of Branches				Number of Leaves			
	3	6	9	12	3	6	9	12
AMF	4	8	7	12	21	33	38	83
AMF+CF	4	7	7	8	19	30	40	80
COMPOST	4	5	6	6	16	22	26	57
CONTROL	4	1	3	3	15	20	27	38
LSD	1	5	5	5	3	7	11	33

The fruit production of okra with regards to the applied treatments were not significantly different from each other at the initial point of collection, except for the plot with the application of AMF which recorded 100 and 50 % significant more fruits than the plots treated with CF and control respectively at the first harvest Table 5. Significantly more harvest was gotten with regards to the different treatments from the 3<sup>rd</sup> harvest resulting in at least more than 20 % increase in fruit harvest compared to the control which had the least number of fruits all through the harvest. Except at the 4<sup>th</sup> harvest were the control had more number of fruits than CF. The use of AMF recorded 67, 50, 78 and 70 % more

significant fruits than the control at 3<sup>rd</sup> & 4<sup>th</sup>, 5<sup>th</sup> & 6<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup> harvest respectively which was all through not significantly different from AMF+CF. Mycorrhizal fungi contribute to; overcoming mineral element deficiencies, improve plant ability to use the soil resources and improve plant performance (McGonigle, 2001; Abbott and Robson, 2006). Douds and Reider, (2003) also reported that inoculation of soil with AMF increases the yield of green peppers. Likewise the use of compost in combination with AMF might have resulted in some beneficial reactions that has resulted in a conducive rhizosphere that has positively influenced the fruiting, growth and yield of okra.



**Table 5: Effect of AMF and compost on harvested fruit of okra**

Treatments	Number Of Fruit (Plot <sup>-1</sup> )							
	1HFNo	2HFNo	3HFNo	4HFNo	5HFNo	6HFNo	7HFNo	8HFNo
AMF	6	8	15	20	15	15	16	17
AMF+CF	5	8	15	22	14	17	17	20
COMPOST	3	7	14	10	17	13	13	12
CONTROL	4	5	9	12	10	10	9	10
LSD	3	4	4	6	5	3	4	5

The okra fruit weight at the first harvest resulted in significant weight with the application of AMF yielding three times the weight obtained from control, similar to Olawuyi *et al.*, (2012) report, this could be attributed to the ability of mycorrhizal to form a symbiotic association with plant roots which are widespread in the natural environment and can provide a range of benefits to the host plant (Gosling *et al.*, 2005). Also, Mycorrhizal fungi play important roles in nutrition and fitness of plants. They contribute to soil nutrient uptake, soil aggregation, soil formation and enhance root absorption area (Gemma *et al.*, 1997; Smith and Read, 1997). They contribute to overcoming mineral element deficiencies, improve plant ability to use the soil resources and improve plant performance (McGonigle, 2001; Abbott and Robson, 2006).

Likewise AMF+CF and CF resulted in similar weight which was about two times the weight of okra gotten from the control plots. Organic matter in soil improves moisture and nutrients retention and soil physical properties (Zane, 2006). Adding compost to garden soil improves soil structures, increases the population of beneficial microbes reduces nutrients loss, boost pH and can suppress certain diseases, incorporating organic matter before planting will produce good yields. AMF still maintained high weight at the second harvest which was heavier than the weight from the other treatments and especially the control. At the third and fourth harvest the use of AMF and AMF+CF resulted in substantial weight of okra which was more than that gotten from CF only and control. As the harvest continues the combination of AMF+CF recorded the heaviest weight which

could be accrue to a synergetic interaction that must have resulted from the combination of AMF+CF hence increasing the solubility of nutrients therefore enabling an increase in nutrient absorption by okra plant which resulted to increase in weight, while the control recorded the lightest okra weight in all. Kelbesa, (2021), also confirm that compost significantly impacted the dry matter accumulation and yield of okra. The benefits derived from organic fertilizers include; reduction in the impact of leaching on the soil, improvement in physical and chemical properties of the soil, conservation of soil moisture, improvement in soil aeration, soil fertility, crop production, environmental sanitation and increase in organic matter content of the soil (Agboola and Omueti, 1982). All treated plots outperformed the control and this improvement is likely attributed to the positive effects of soil amendment on soil health. Although, there is a point at which indiscriminate use of these fertilizers without usual soil testing to ascertain the type and dosage required constitute inherent hazards to the soil chemical composition, waste of resources, retarding plant growth and fruit production (Igbinnosa *et al.*, 1992). Interaction of AMF at the rhizosphere can improve nutrient availability providing a conducive friendly environment for microbes existence and enhancing their activities. However, a drastic reduction in weight was recorded within the 4<sup>th</sup> and 5<sup>th</sup> harvest which could be due to sudden rainfall break which resulted in drought, though was stabilized at the 6<sup>th</sup> harvest and at the 8<sup>th</sup> fruit harvest the fruit weight reduced drastically which implies that the crop has completed it's life cycle.

**Table 6: Effect of AMF and compost on harvested okra Fruit weight**

TREATMENT	Fruit weight g plot <sup>-1</sup>							
	1HWF	2HWF	3HWF	4HWF	5HWF	6HWF	7HWF	8HWF
AMF	96.1	61.7	30.1	26.5	9.2	13.2	59.6	9
AMF+CF	48.9	31	39.6	35.9	5.8	52.7	134.7	23.1
COMPOST	48.4	43.9	21.7	12.4	8.6	33.8	73.9	15.8
CONTROL	29.8	20.1	15.2	15.9	4.3	23.9	47.2	17.1
LSD	48.9	45.02	13.96	28.4	5.6	23.8	68.7	21.11

## 5.0 CONCLUSION

This study concludes that there was significant okra performance to the application of AMF (*Glomus intraradices*) which was not significantly different in most instances from the observed trend on okra responses, when AMF was combined with compost fertilizer as compared with the control plot. Hence the application of soil amendment with sole Arbuscular Mycorrhizal Fungi (*Glomus intraradices*) and its combination with compost will enhance okra growth and yield performance without necessarily mining the soil nutrient for future use in the study area.

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